

# A Dynamic Model of Metric Rhythm in Electroacoustic Music

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## Abstract

*The possibilities offered by electronic composition tools, while liberating, make difficult the dynamic use of organized rhythm in electroacoustic music. This paper explores a model stemming from interactive electroacoustic work by the author that adapts aspects of the hocketed, disjunct rhythmic textures of funk styles for use as a developmental musical parameter. These methods for generating rhythm that facilitate transformation in ways more naturally manipulated by computer-based tools are demonstrated in theory and in use by the author.*

## 1 Introduction

Modern electronic tools for music composition allow a practically infinite variety of time relationships; however, this freedom has made it difficult to organize rhythm as an active developmental parameter of a musical work. Most tools either leave composers adrift in a practical continuum, or force them to wrestle with (or settle for) conventional eighteenth-century metric patterns. A common solution is to use a multitrack audio production tool that allows metric grids to be placed over a temporal continuum. It is possible for multiple sounds to be organized according to different metric grids, but each grid is static, is limited to conventional meters, and makes for tedious work placing each sound. After bouncing a static rhythmic passage to a single file, a phase vocoder or granular sampling application could be used to warp the rhythm in controlled ways, but the attack envelope of the sounds would be distorted as well. Some applications offer a tempo map in which time can be warped without distorting the original sounds, but these tools can usually only support one (conventional) meter at a time and still require tedious placement of individual sounds. As one alternative to these limitations on rhythmic organization and development, the model presented here, developed in the Max/MSP programming environment, gives unique dimensions of flexibility and structure in electronic or acoustic algorithmic composition, in or out of real-time.

## 2 Theory

This work was inspired by attempts to describe the principles active in musical moments that are

simultaneously engaging and elusive, the combination of which evokes a special excitement in the listener. This seems to be mainly the realm of rhythm and texture, and is a key element of funk styles. The effect is achieved through a kind of balance between predictability and surprise, such that a listener is compelled to follow, despite being continually shaken loose. This is related to musical discussions of entropy (in the form of surprise; Meyer 1967): the balance is somewhere between redundant stasis and continuous change. When achieved, the effect is synergistic, as if the stimulus were much more complicated than it actually is and more exciting than the simple sum of its components. The term *tickle* is used here to refer to this effect of engaging elusiveness.

Study of funk metric structures has revealed that the music is usually unstable at the level of the single 4/4 measure, but stable at the levels of the eighth note pulse and the two-measure segment. Whereas the former is more widely recognized, the stability of the two-measure segment comes from a tendency to disrupt every second downbeat (usually by delay or anticipation). One measure often does not look like the next measure, but one pair of measures is often very similar to the following pair. Between these stable levels is where the tickle is evoked. The quarter note beat is usually unstable; the steady eighth note pulses are divided into groups of two or three by accents. It is in the mixture of two- and three-pulse groupings that elements of stability and surprise can be manipulated. This is congruent with studies demonstrating that human perception is most sensitive to a specific range of durations, peaking around one half second (Fraisse 1963, Povel 1981). It appears that the ticklish component must be focused within this range to be effective and that it needs stability on adjacent levels to react against.



Figure 1. The guitar riff from James Brown's "Give It Up or Turnit A Loose" (1968/1996) demonstrates an accent pattern of 2, 2, 3, 2, 2, 3, 2. Note how a pulse group lies across the barline.

Based on this analysis, the terms “beat” and “measure” are not efficient for discussing this kind of structure. Instead, a model of funk metric rhythm can be built up from steady *pulses*, collected by twos or threes into *pulse groups*, whose initial pulses are accented. The 4/4 meter is replaced with an *accent pattern*, the pattern of two- and three-pulse groupings that repeats (usually) every two measures. Tickle is established through the combination of two- and three-pulse groupings that compels listeners to follow, but evades predictability.

### 3 Application

The model presented here describes metric rhythm in three independent layers: the accent pattern, sound pattern, and performance variations. As a starting point, it uses metrical patterns typical of funk and a three-voice (low, middle, high) drum set.

#### 3.1 Accent pattern

An accent pattern is generated through a randomized selection of two- and three-pulse groupings (i.e., a list of twos and threes). The length (number of pulses) of the pattern may be specified or randomly chosen. At this point certain filters may be put in place that reject undesirable accent patterns. For example, allowing four consecutive two-pulse groupings suggests a 4/4 meter, and three consecutive three-pulse groupings suggest a traditional 9/8, both of which would stifle the tickle effect with predictability at the accent pattern level. Also, rejecting patterns with an odd number of pulses makes a pattern more accessible by allowing constant foot-tapping at the quarter note level (assuming a pulse to be equal to an eighth note) without getting lost. This is not to suggest dance music as a purpose, but it can allow a listener to follow a pattern through some of the more extreme transformations discussed below.

This accent pattern is an inaudible, abstract construction. Its values are read in sequence according to a (normally) steady pulse and a counter that marks each pulse as the first, second, or third member of the current pulse group. The counter steps up to the value indexed within the accent pattern, then moves to the next value (a two or three) and counts out that many pulses before moving again.

#### 3.2 Sound pattern

The sound pattern determines the order in which sounds will happen, but still does not dictate the final rhythm. It is independent from the accent pattern and variation layers; the character of a sound pattern will be preserved across different accent patterns or variation settings. Given a ticklish accent pattern, the sound pattern for each voice can be described in rather simple terms with interesting results. Drawing from the example of a three-piece drum set, the low voice (like a bass drum) may play the first pulse of the

pattern (which is always accented), the first accent after the midpoint of the pattern, and two randomly chosen pulses (Fig. 2). Articulating some randomly chosen pulses allows irregularities in the pattern that give each instance a unique feel while maintaining the functional skeleton of each voice and without requiring new sound pattern algorithms. A middle voice (like a snare drum) may be designed to play the second and fourth accents, the second and fourth accents after the midpoint, and two randomly chosen pulses, to perform a back-beat function with some added irregularities for character. Finally, the high voice (like a closed hihat cymbal) may play every pulse in the pattern, a typical time-articulating role for such a voice. The sound pattern ultimately sends signals as to which sounds should play on a given pulse; this is still subject to distortion by the variation layer before any sound is heard.

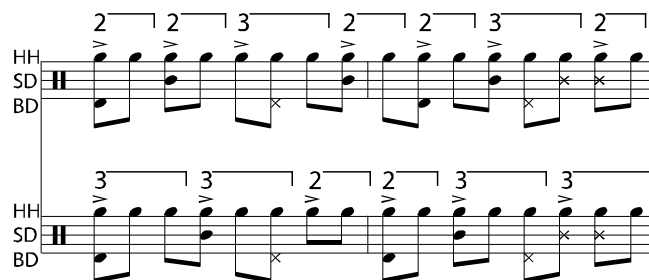


Figure 2. The character of a sound pattern is preserved when the accent pattern is changed. “X” noteheads represent randomized choices (kept constant for this example).

#### 3.3 Performance variations

A number of variations can be applied to the signals from the sound pattern during live performance. This gives the pattern even more life, as two consecutive iterations of the pattern may be different, while still being true to the character of the accent and sound patterns. The variation layer works as a sieve-like filter, in its simplest mode choosing to ignore a trigger, based on a probability-weighted random process. Some other variations typical of the funk drum set model are late hits (delayed by a half pulse), double strokes (two sixteenth notes in the place of an eighth note), and enclosures (playing the sixteenth notes just before and after, but not on, the designated pulse). These can be realized by delaying the signal (late hit), along with the optional throughput of the original trigger (double stroke). The enclosure variation, since it involves a trigger that occurs before its corresponding pulse, requires that all triggers are by default delayed by the duration of a half pulse, so that setting the delay to zero would allow a stroke to happen “before the beat.” This default delay could also be manipulated so that an entire voice might be made to play slightly ahead of or behind the others.

It is this layer that actually triggers sounds, but they are not quite ready for output. So far, every sound is (presumably) played with equal volume, which would

thwart a sense of hierarchical functions within the pattern. The final step in this model is to consult the accent pattern counter again to determine where the current pulse stands within its pulse group. In the simplest model, accents are realized by allowing the first pulse of each pulse group to sound at full volume, while other pulses within the group are made progressively softer. This automatically creates two types of accent: the accent following a three-pulse grouping could be considered to have greater emphasis than one following a two-pulse grouping, since the difference in loudness between the third pulse of a group and the following accent is greater than that between the second pulse (of a two-pulse grouping) and the following accent. This final stage is the most significant for the realization of the abstract accent pattern. As the last stage in the process, it ensures that whatever sounds happen, and whenever they do, they will fit into this underlying abstract structure.

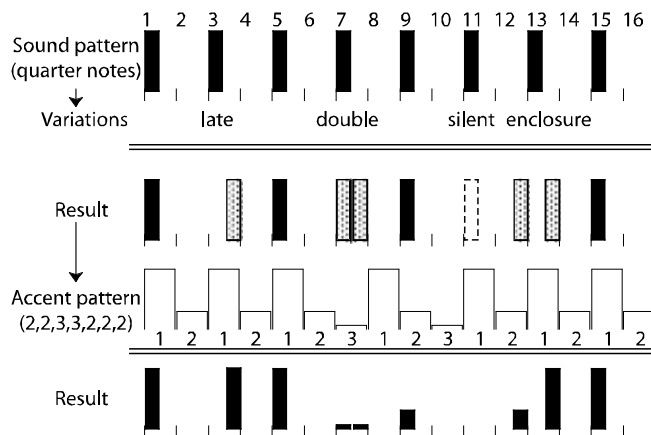


Figure 3. The final rhythm comes from the superimposition of the sound pattern, variation, and accent pattern layers.

## 4 Transformations

In a straightforward emulation, the main parameters to control would be the pulse rate (corresponding to tempo), the selection of accent and sound patterns used, and the probability of each type of variation being selected. Conservative manipulation of these parameters yields an effective simulation of funk drum set patterns; however, the purpose of this model is not to imitate something that has already been done. Like many models, it is intended to establish a set of parameters by which something can be effectively described, for the purpose of exploring the varied and extreme limits of these parameters while preserving some qualities at the heart of the originally modeled object – in other words, to bring the modeled object to states into which it could not ordinarily go. In this case, a model of funk drum set patterns has been established for the purpose of exploring the extremities of metric rhythm while maintaining the tickle effect.

Unconventional accent patterns can be created by allowing an odd number of pulses, or using longer patterns.

More advanced transformations involve controlling parameters compositionally, that is, in controlled ways over time or in response to live input. Compositional techniques less likely to be implemented by a live drummer include forming gaps in the pattern on certain pulses or in response to certain real-time stimuli, or gradually shifting prominence from one type of variation to another. The pattern could be brought in and out of “focus” by manipulating the default delays in each voice differently – extreme values here would go far in deconstructing a pattern while preserving a fuzzy sense of tempo and accent structure. The accent pattern counter could be altered to gradually shorten or lengthen a pattern, or to cycle through a window shifting around within a longer pattern.

Tempo modulation is another possibility. Key parameters here are the amplitude and shape of the low frequency oscillator that is modulating the tempo and the period of the oscillator in relation to the accent pattern. The subtlest use of this effect is a low amplitude (e.g., within a few bpm) sinusoid, in phase with the accent pattern. This would contribute to the overall “feel” of a beat, by slightly rushing or dragging the tempo, but in the same way each time through the pattern. As the period of the oscillation is gradually changed, making it out of sync with the accent pattern, the effect is more disturbing, like listening to a warped record. Greater amplitudes and period lengths enter the realm of rubato playing, or accelerando and ritardando. The wildest effects of this technique result from nonsinusoidal shapes: sudden or jagged changes in tempo create drastic transformations of the rhythmic pattern while preserving a sense of unity and function as a pattern.

A more radical transformation exploits the basis of the model as represented in three isolated layers. In the transformations discussed so far, the sound actualities have been synchronous with the underlying abstract structure, like one usually conceives of the mind and body acting in tandem. However, since each layer has been distinctly defined, it is possible to disembodify the sounds from their structure with intriguing results. This is achieved by manipulating the counter that reads through the sound pattern in tandem with the accent pattern. By multiplying the counter’s output by a coefficient and truncating it before indexing the sound pattern, the sound pattern can be expanded or condensed while leaving the abstract accent pattern in place.

For example, with a coefficient of 1.5:

Accent pattern counter:	0	1	2	3	4	5	6	7
Sound pattern index:	0	1	3	4	6	7	[9]	[10]

The overall order of sounds is preserved, but some sounds are skipped. Furthermore, unless the sound pattern has entries for the ninth and tenth pulses, the pattern will form a silent gap at the end before repeating. The accent pattern, however, will continue unchanged and impose accents in the same places, even though different sounds may be there. When the coefficient is gradually changed away from 1.0,

the resulting pattern gradually dissolves, but the order of sounds, tempo, and accent pattern are unchanged.

## 5 Sounds and extensions

For simplicity, the sounds triggered by the sound pattern have so far been assumed to be like those of the drum set, but this need not be so. Any sound may be used, and many types of function (drum-like or not) can be described in the sound pattern algorithm. In addition, the values from the accent pattern counter might be used to activate alternative sound samples to articulate accented pulses. Similarly, the variation layer could be used for many kinds of intervention, such as choosing effects processes or output speakers.

Beyond this, since the sound pattern only sends triggers, it could be used to initiate other (non-sounding) events, or trigger the opening of windows on long playing sound files (and the windows need not be only one pulse long). The separation of layers allows each sound to be transformed, independent of its role within a pattern. With an extreme treatment of the pulse rate, this model can generate granular timbres with intriguing textures. In another application, these triggers could be coupled with a pitch selection process to create pitched contrapuntal textures. Much more complicated textures can be built up from multiple sets of voices with different accent patterns, used simultaneously and transformed independently.

## 6 Use, future work, and conclusions

This model was originally designed for an improvisatory composition for double bass and live electronics (using Max/MSP). The basic rhythmic model has been demonstrated at the Center for Experimental Music & Intermedia. It also has served a primary role in the live electronic music for *StillMotion*, a recent collaboration with choreographers Rosane Chamecki and Andrea Lerner and the dance and visual arts departments of Texas Woman's University.

The work described here will continue to be developed within a study of musical rhythm and texture. The next generation of the model will incorporate recent work in computerized beat detection and human perception of tempo and pattern (Large 2001, Rowe 2001) in an endeavor to turn them around for use as generative processes for live electronics or algorithmically composed music.

The results of this model are pleasing in its successful arousal of the tickle effect and the flexibility of the system. This method allows independent manipulation of sound and rhythm without necessarily affecting both. The parameters are accessible for manipulation as dynamic parts of musical development in or out of real time, and it offers a versatile set of transformations suitable for multiple compositions in varied styles. It is the author's hope that thinking along these lines (although not necessarily using the same terms) will allow composers to adapt our rhythmic abilities to

sound-based electronic composition in a deeper way, allowing rhythm and texture to carry such significant roles as pitch often has.

Note: Audio examples and further discussion of the concepts presented here are available on the world wide web (Morris 2004).

## 7 Acknowledgments

Thanks to Joseph Butch Rovani for his insights during the formation of this model.

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